



# **A Perspective on Science and Exploration**

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AIAA 2nd Space Exploration  
Conference

**Implementing the Vision**

# NASA 2003 Strategic Plan



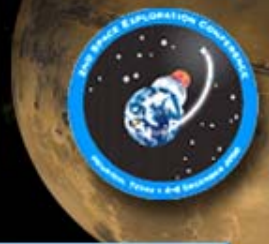
## **The NASA Vision**

To improve life here,  
To extend life to there,  
To find life beyond.

## **The NASA Mission**

To understand and protect our home planet,  
To explore the universe and search for life,  
To inspire the next generation of explorers  
... as only NASA can.

# NASA Strategic Plan 2006



## NASA's Mission and Vision



Congress enacted the National Aeronautics and Space Act of 1958 to provide for research into problems of flight within and outside Earth's atmosphere and to ensure that the United States conducts activities in space devoted to peaceful purposes for the benefit of humankind. Nearly 50 years later, NASA proudly pledges that the Agency will continue the important work begun in 1958 by pursuing the American tradition of pioneering and exploration to redefine what is possible for the benefit of all humankind and by using NASA's unique competencies in scientific and engineering systems to fulfill the Agency's purpose and achieve NASA's Mission:

***To pioneer the future in space exploration,  
scientific discovery, and aeronautics research.***

On January 14, 2004, President George W. Bush announced *A Renewed Spirit of Discovery: The President's Vision for U.S. Space Exploration*, a new directive for

# NASA 2006 Strategic Goals



## NASA's Strategic Goals

**Strategic Goal 1:** Fly the Shuttle as safely as possible until it's refinement, not later than 2010.

**Strategic Goal 2:** Complete the International Space Station in manner consistent with NASA's International Partner commitments and the needs of human exploration.

**Strategic Goal 3:** Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.

**Strategic Goal 4:** Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.

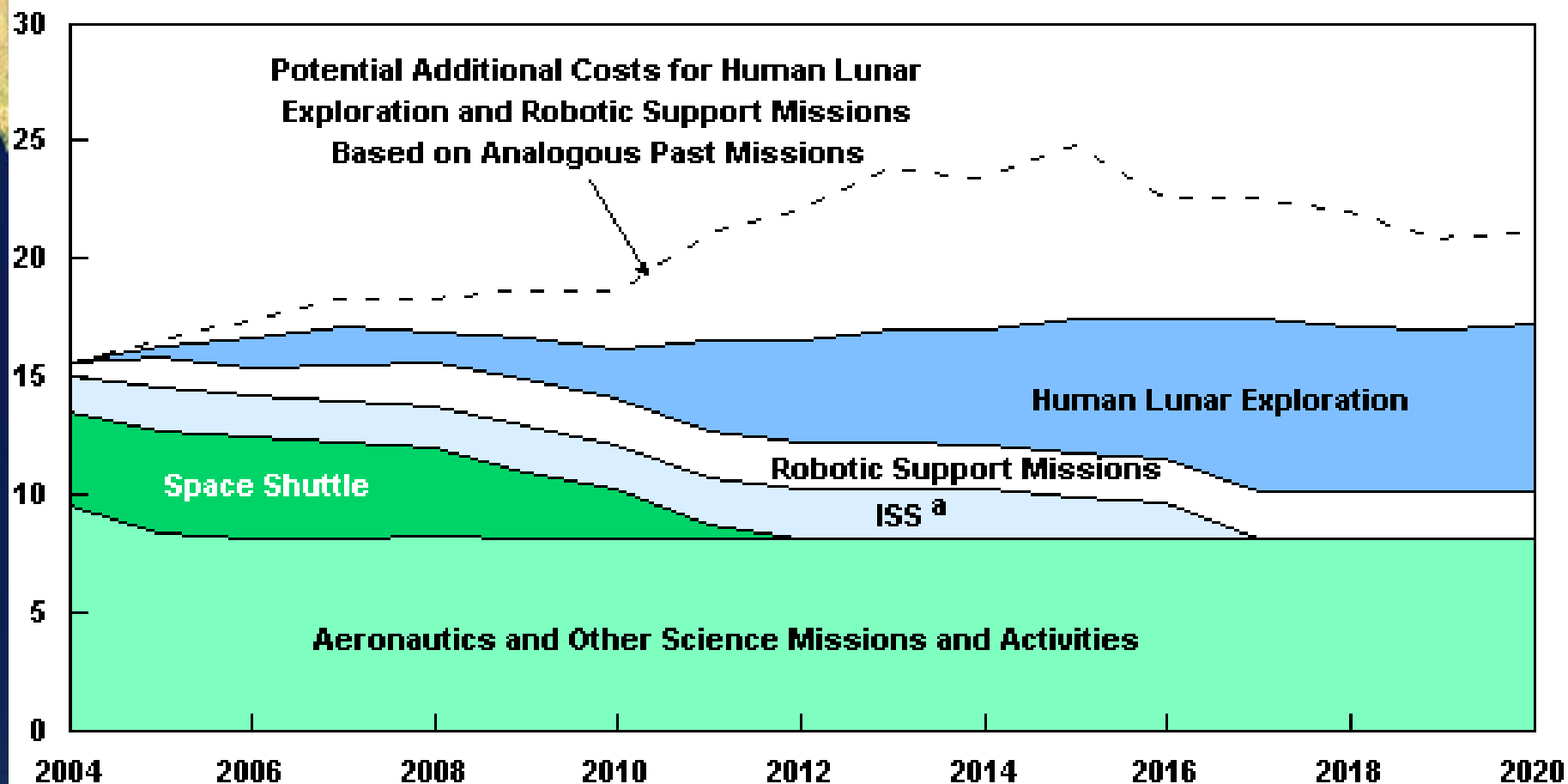
**Strategic Goal 5:** Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.

**Strategic Goal 6:** Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.

**Sub-Goal 3C** – Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space

# CBO Cost Estimates

## Billions 2005 dollars



# Suggestions

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- Implement the Aldridge Commission science Plan
- Work closely with the scientific community to develop an that will facilitate and provide new scientific capabilities for space research
- Reexamine the relationship of the science community to NASA
- Establish achievable expectations for success

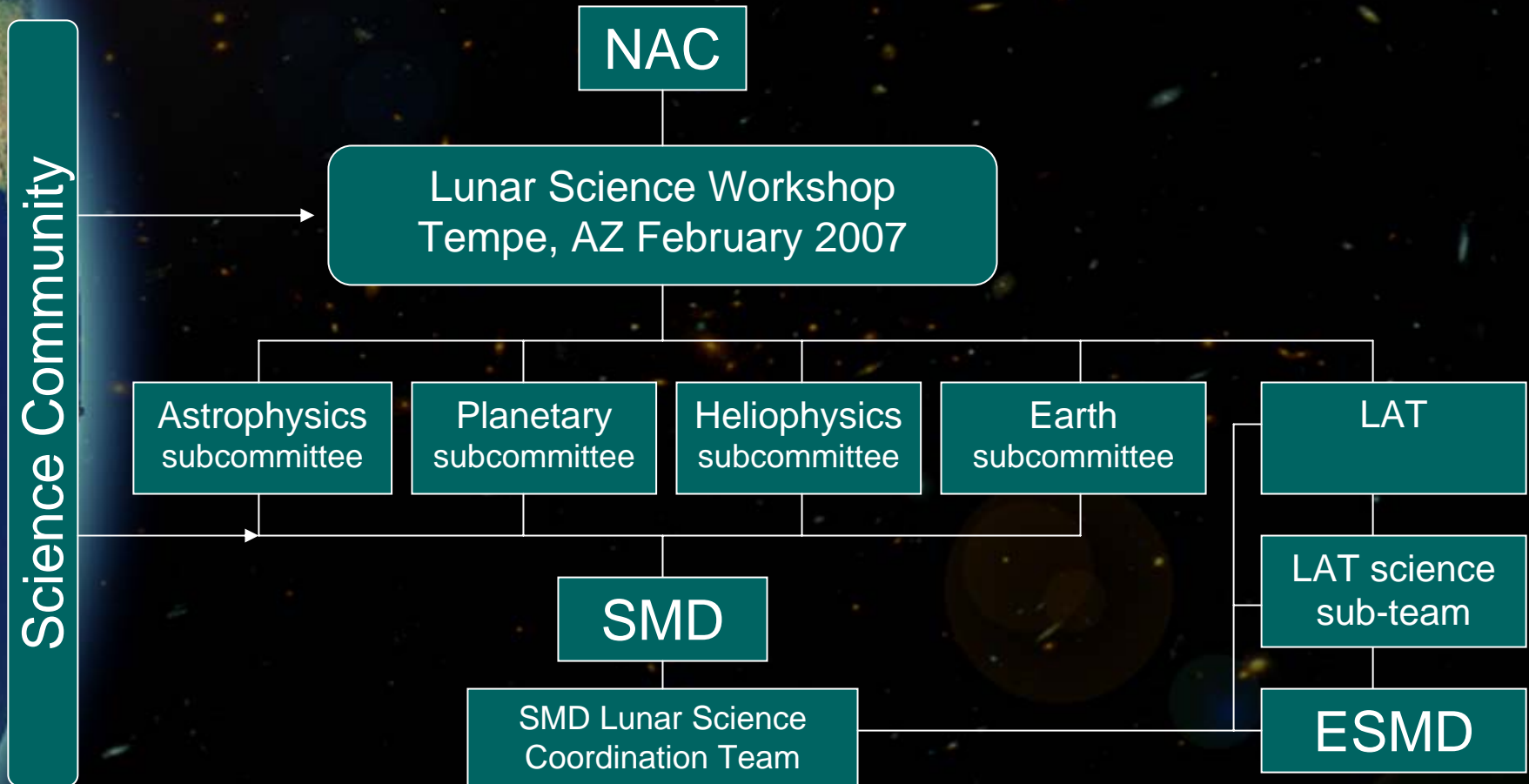
# Aldridge Report's Science Outline

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- **Origins** – the beginnings of the universe, our solar system, other planetary systems, and life
- **Evolution** – how the components of the universe have changed with time, including the physical, chemical, and biological processes that have affected it, and the sequences of major events
- **Fate** – what the lessons of galactic, stellar, and planetary history tell about the future and our place in the universe

# Science Information Flow





# Implementing the Vision

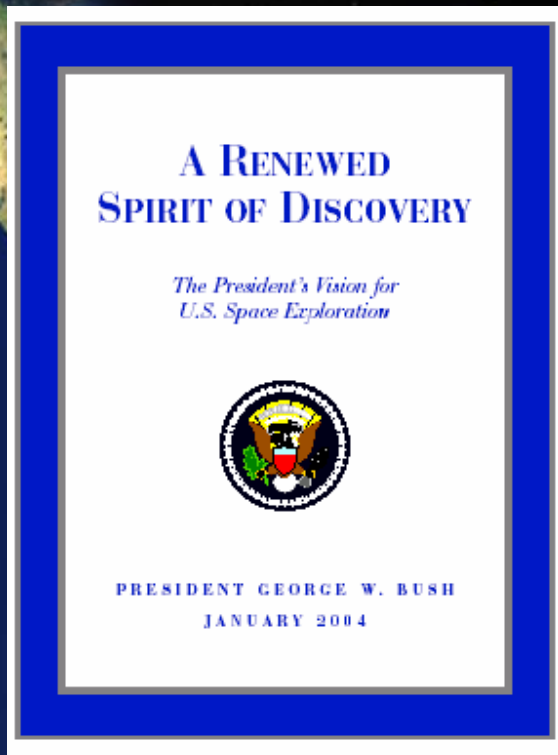
**Space Exploration Conference  
2006**



# Backup Slides

# Vision for Space Exploration

## Jan 2004



- Goal and Objectives

- The fundamental goal of this vision is to advance U.S. scientific, **security, and economic interests** through a robust space exploration program.
- In support of this goal, the United States will:
  - Implement a sustained and affordable human and robotic program to explore the solar system and beyond;
  - Extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations;
  - Develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration; and
  - Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests

Implementing the Vision

# Aldridge Report



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The Aldridge report, which considered how to implement the Exploration Vision, found that

“the space exploration vision will be enabled by scientific knowledge, and will enable compelling scientific opportunities to study the Earth and its environs, the solar system, planetary systems, and the universe”

# Covering Higher Costs

## CBO Analysis

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- Increase NASA Budget by 23% for the period 2005 to 2020
- Lengthen schedule and postpone first manned landing on the moon from 2020 to 2027
- Reallocate 46% of total science funding

# Shuttle Promise vs. Delivery (Roger A. Pielke, Jr May 1993)



Table 1. Summary comparison of goals and achievements for the Shuttle programme through 1990.

Goal	Promise	Performance	Difference
First flight	1978	1981	3 years
Total cost	\$51 billion	\$65 billion	\$14 billion
<i>Average cost per flight</i>			
Including development	\$88 million	\$1.7 billion	\$1.612 billion/ft
Excluding development	\$14 million	\$1.1 billion	\$1.084 billion/ft
<i>Flight rate</i>			
Annual average	48	4	44 flights/year
Total	580	37	543 flight
Reliability <sup>a</sup>	0.9997 (3333:1)	0.966 (30:1)	2 orders of magnitude
Cumulative reliability <sup>a</sup>	2311 flights	21 flights	2290 flights
Payload mass	65 000 lb	49 000 lb	16 000 lb/ft
Manned capability	Yes	Yes	—
Reusable	Yes	Yes	—

# Science on the Shuttle



- Early science experiments in payload bay, GAS, and cabin beginning in 1982
- 1994 was the busiest year ever for atmospheric science observations from the Space Shuttle, with five of the eight shuttle flights having atmospheric science measurements as their primary or strong secondary goals. Reduced budgets and a very busy Shuttle manifest place strong constraints on possible implementation of expanded use of the Space Shuttle for atmospheric science measurements in the coming years.
- Hubble servicing missions SM-1, -2, -3A and -3B, 1993-2002
- Since its first flight in June of 1982, NASA has successfully flown 167 GAS payloads on the Space Shuttle to support Earth and space science research, new technology development and promote student involvement in science and engineering. Experiments have been flown for schools, the US government, foreign governments and private companies.
- Aug 2006 – Student Science Experiments (GAS) cancelled as a “luxury we can’t afford” (Small Satellite Conf.)

# Historic Cost Growth

## Potential for Science Reductions



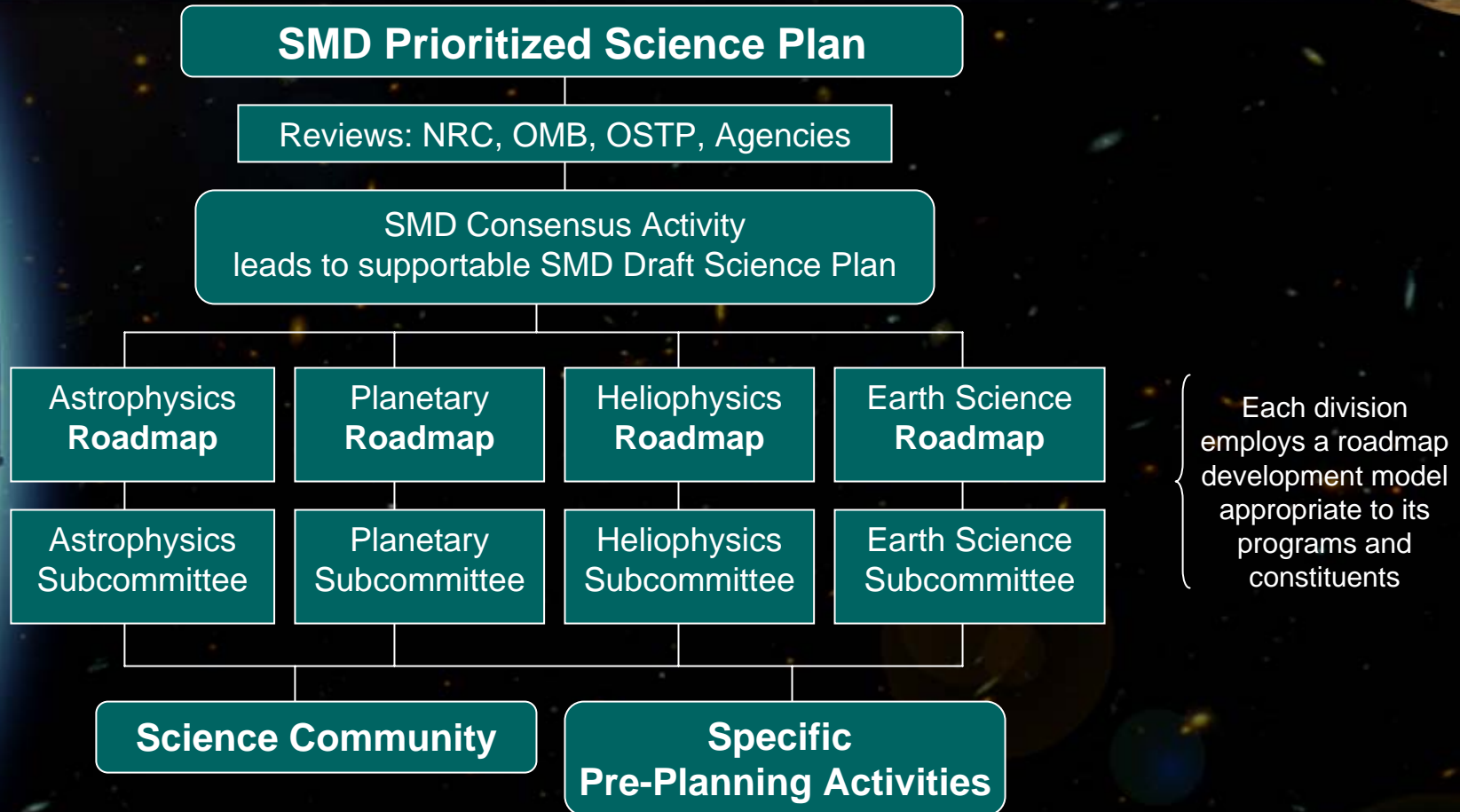
Program	Cost Estimate	Final Cost	Cost Growth
• Lewis & Clark	\$2500	\$38,722	15.5 X
• Shuttle Development	\$51B	\$65B \$150B (LCC)	1.3 X
• Apollo Program		\$170B	
• Space Station	\$ 8B	>\$60B \$100 B (LCC)	12X

# VSE Science Input via NAC Science Subcommittees



- Astrophysics - Community workshop (last week)
- Planetary Science - using established advisory groups (LEAG, MEPAG)
- Heliophysics - Lunar science subpanel community outreach and report
- Earth Science - individual community white papers
- All subcommittee activities will be informed by the NAC-sponsored workshop and community white papers

# How do we prioritize opportunities along the way?



NASA Science Mission Directorate has a well validated process for establishing science priorities within their resource allocations. Once complete, the lunar science opportunities information should enter into this process in the same manner as other SMD Pre-Planning Activities

**Implementing the Vision**

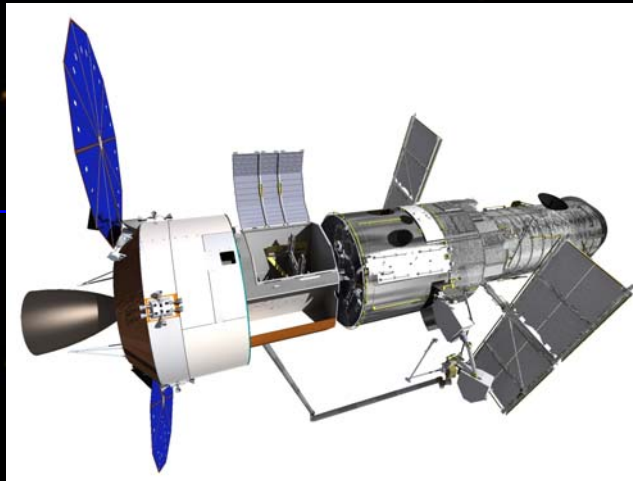
# HST Robotic Servicing Mission Ops Concept



TDRSS

HST LEO

1. SSM Launched on Ares I, Ares I recovery ops



8. HST resumes science ops

7. SSM undocks and deorbits

2. HST terminates science ops and configures for capture
3. SSM rendezvous and docks with HST, SSM controls HST+SSM stack for repair ops, HST configures for repair
4. SSM deploys robot, tools, replacement items
5. Dextrous Robot performs repairs in/on HST, stows replaced parts, stows itself
6. SSM performs HST reboost & orbit maintenance, configures for deorbit, HST configures for release

SSM CC

Robot CC

HST CC

Earth  
Surface

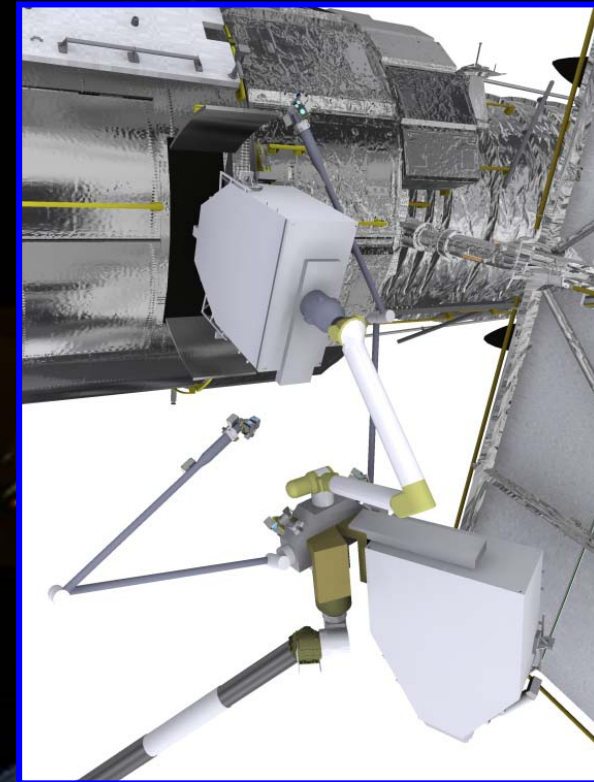
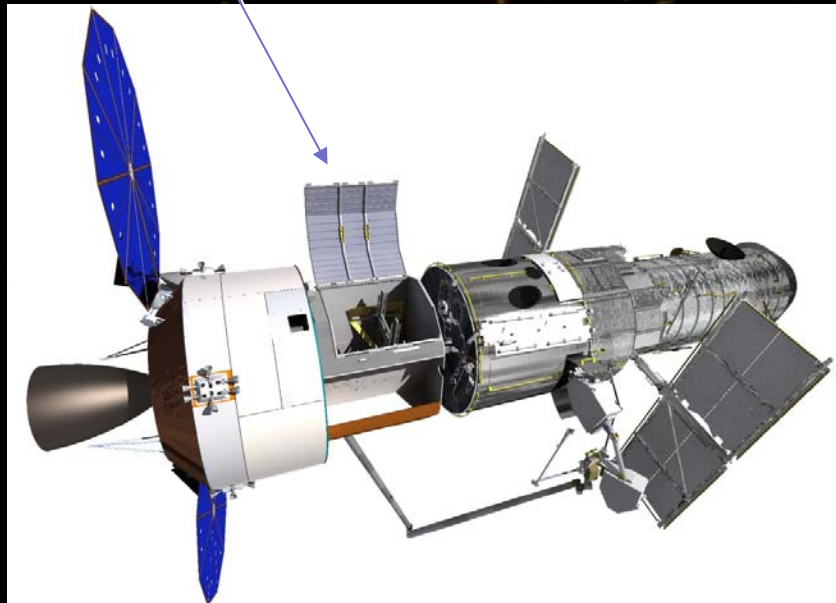


Implementing the Vision

# HST Robotic Servicing Mission Ops Concept



- 11 ft tall Hubble Robotic Servicing Vehicle with no DM
  - 39 ft robotic arm w/telescoping booms
  - Dextrous robot with single 7DOF precision task arm and 2 5DOF camera support arms
  - 1 radial instrument ORU, 1 equipment bay ORU



Implementing the Vision